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What is the Taste of CO2? The sustainability of Icelandic food systems in the face of climate change

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Abstract

Food security in the arctic and subarctic is an area of growing research and concern as climate change continues to alter the availability of traditional foods eaten in remote areas, especially as shipping food has questionable sustainability and contributes to rising CO_2 levels. Previous research has noted changes in the Icelandic diet making it more reliant on foreign imports, although there is still strong localized agriculture. Because of its geothermal activity, Iceland has a unique advantage over other high-latitude countries in growing food with a minimal carbon footprint, although that potential is unequal throughout the country. This study utilized available data for current food imports and domestic production, as well as the energetic costs of food production in greenhouses in Iceland in order to assess the maximum sustainability of meeting current food needs on the island nation. Interviews were also conducted with local farmers and local food experts to assess Icelandic farming techniques, struggles, and production. As climate change is likely to cause drastic changes to the limits of sustainability, the sustainability of food imports and production were placed within the context of local climate changes in Iceland. Based on estimates for the emissions related to local and imported vegetables and their path from farm to consumer, Iceland should continue to build farming infrastructure and increase reliance on local produce as a way to increase food sustainability. This will also increase the food security of the country by relying on systems that will not as easily be thrown into disarray by world conflict or natural disasters. In order to further improve the sustainability and security of food systems, Iceland can also implement local changes to limit farm and food transport emissions.

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Table of Contents

1. Introduction

Iceland is an island nation of little over one third of a million people, located in the North Atlantic Ocean. Settled in the late 9th century by the Norse as a largely agrarian state, slightly more than 94% of the population is currently urbanized, with about 50% living in the capital region around Reykjavík. Iceland's economy has traditionally been dependent on the fishing industry, although tourism has become increasingly important with the gradual decline in agriculture and fishing as part of the national income (Central Intelligence Agency 2016; Farmer's Association of Iceland 2009). While geographically insular, Icelandic culture has been heavily influenced by historical Norwegian and Danish rule, and American occupation during World War II (Central Intelligence Agency 2016).

As a nation, Iceland prides itself on its extensive use of sustainable alternative energy, and its conservation of traditional culture. These two points of identity intersect in Iceland's national food production. With agriculture and animal husbandry built into the traditions of the island, Iceland's eating habits support food that has been traditionally produced on the island, but there has been a strong influence from mainland Europe that has changed the national diet, necessitating imports from around the globe (Sigurgeirsson, Steingrímur 2001).

Previous literature on food production in Iceland has focused on food security concerns for the country. While Iceland developed as a self-sufficient nation, its growing reliance on foreign imports has made the country susceptible to blocked food distribution from both internal and international turmoil (Jóhannsson, Orri 2011; Butrico, Gina Marie 2013). These weak points in food security have also been linked to sustainability, as any use of oil in Icelandic food production ties Iceland to a volatile world market (Butrico, Gina Marie 2013). In this study, sustainable food is defined as food that is produced in ways that do not rely on high-emissions resources like oil and gas, and can be produced with low environmental impact. Food security describes the ability of citizens to access enough nutritious throughout the year.

There have been limited studies on Iceland's imports, showing the drastically increasing amounts of imported food, especially in the last 50 years (Jóhannsson, Orri 2011). More than 60% of vegetables in Iceland are imported, although the government levies tariffs on international foods that can be produced in Iceland in order to protect existing internal agriculture (Farmer's Association of Iceland, 2009; US Commercial Service 2006).

Perhaps because of Iceland's overall strong reputation for being reliant on renewable energy, and thus largely environmentally conscious, there is limited research on the current sustainability of the country's system of food production, importation, and distribution. While the area of greenhouse crops in Iceland has increased by more than 28,000 m^2 since 1990, sustainable in-country vegetable production has decreased by 10% since 1991. Additionally, many of the components used for growing produce and other locally made Icelandic products are imported, feeding into food insecurity concerns, but also utilizing carbon-heavy shipping methods that contribute to global warming (Farmer's Association of Iceland, 2009; Jóhannsson, Orri 2011).

An investigation is therefore needed to remedy the blind spots in research regarding Iceland's food sustainability, beginning with assessing the current environmental costs of feeding the country through both local production and importation, and then evaluating the viability and methods of increasing the overall food sustainability of the country.

Because of the ongoing and projected effects of climate change in the arctic region, the current and potential sustainability of Iceland's food systems must be placed within the context of climate change. The arctic is warming at an accelerated rate relative to the rest of the globe, which makes these considerations pressing, but there are uncertainties regarding the effects that climate will have, and few studies on the effects of climate change on arctic agriculture (IPCC 2014). While this study does not directly investigate the effects of climate change on cultivation, it is an important factor that will be considered in projecting the viability of agricultural development in Iceland.

This study aims to assess and describe the current weaknesses of Icelandic food systems in terms of high-emissions sources and vulnerability to catastrophic events, and to develop recommendations for improvements to the security and energy-efficiency of providing food for the country, particularly through horticulture. Because of the continued importance of global climate change around the world and its amplified effects in the arctic, the ties of climate change to food production and importation in Iceland will be considered. Additionally, this study will build on available data regarding current food production in Iceland and to assess its potential for maximum sustainability in the future, accounting for environmental changes due to climate change.

2. Methods

This study was conducted on site in Iceland, beginning with a literature review of current research into the viability of farming in Iceland and current methods being employed to promote and improve circumpolar agriculture, both locally and globally. The current agricultural output of Iceland was derived from government reports, with data on farm output from local farming organizations.

2.1 Interview methodology

Interviews were conducted with experts in Icelandic local foods and farmers across the country to assess the carbon footprint of individual farm and greenhouse operations, and the sources of energy used for agricultural endeavors. Three interviews were conducted over the phone with farmers and representatives from organic farms in different regions of Iceland. While the interviews were only loosely guided, questions were asked about the kinds of soils and fertilizers used, and their origins, the sources of energy used on the farms, where the food is sold, and the interviewee's perceptions of farming in Iceland.

Two in-person interviews were conducted with experts on local food in Iceland. Interviewees were questioned about their thoughts on current challenges to local agriculture and sustainable food in Iceland, opportunities for increasing agriculture throughout the country, and the current availability of Icelandic products in stores.

In preparation for these interviews, ethical interview practices were taken into account, and are described in Appendix 1.

2.2 Emissions calculations

Using open-source data on shipping emissions and the BSR Clean Cargo Working Group guide to calculating CO_2 emissions from ocean transport, estimations were made on the emissions related to shipping food from Iceland's major import partners. Using guidelines from the Environmental Defense Fund's Green Freight Handbook, estimations of the emissions related to transporting food overland by truck were made. These two estimations were then compared and compiled in a table in order to break down the component and total emissions related to imported and local food, and determine a more sustainable system. Using these comparisons as a guideline, areas of major carbon emission were identified and a literature review was used to assess possible solutions to improve sustainability within the food system.

Because of the diversity of climates, growing methods, and energy sources in the countries that export produce to Iceland, it is difficult to generalize the efficiency of growing food abroad versus growing food in Iceland. Table 3 estimates the emissions related to horticulture farmed overseas and imported to Iceland from major food import partners, with farming emissions estimated at releasing 30%, 50%, and 70% of the CO_2 of Icelandic farms over a year. Farming emissions are the average of emissions from geothermal and non-geothermal greenhouses in Iceland. Overseas transport emissions are calculated as the average of refrigerated and dry cargo. While the estimations for the emissions from growing vegetables overseas are based on a year of production, the overseas transportation emissions are calculated for a single shipment.

2.3 Food security studies

Available literature was also used to assess the security of Iceland's current food system and its vulnerability to economic and natural disasters that can block food production and distribution, and its connections to sustainability, especially in the face of global climate change. This was done using information on past events that have disrupted food systems in Iceland, the projected effects of climate change on events that can interfere with food production and transportation, and information on how sustainable farming practices would be affected by climate changes.

Qualitative data from interviews, estimations on the comparative emissions from imported and domestically produced agriculture, and assessments on threats to food security in Iceland were compiled in order to map comprehensive steps to improve food sustainability and security in Iceland.

3.0 Results

3.1 Interviews

Five interviews were conducted, three over the phone, and two in-person. Icelandic farmers that were interviewed for this study were found based on their online presence, and often had a tourist component to their operation. Interviews lasted approximately 10 minutes and were loosely structured to focus on farming methods and materials, as well as the perspectives of farmers on the agricultural scene in Iceland.

The first interview conducted took place on October 24, 2016, with a representative of Sólheimar Eco-Village in South Iceland. Questions focused on the source materials and energy used for their greenhouses, where their produce is sold, and what methods they employ in their growing regime. Sólheimar reports an overall goal of eco-friendly agriculture methods, using organic fertilizers and soils, although some are imported from other countries. The farm's own geothermal pump is used to heat the greenhouses, which significantly lowers the cost of the farm operations. Still, electricity is the most expensive part of running the farm, and is quite pressing because of the limited sunlight available during the long winter. To deal with this struggle, the growing season ends in December and begins again in February, avoiding the darkest part of the year. About 95% of the food produced is sold outside the Eco-Village, using a food distribution company to get their produce to Icelandic stores.

The second interview was conducted with Móðir Jörð farm in Eastern Iceland on October 25, 2016. This farm is organic and primarily grows barley, producing up to 100 tons every year, along with up to 100 varieties of vegetables, herbs, and other plants. The farm is located in a cold area, with no geothermal potential, and is the only full-time outdoor operation in the area that is fully dependent on the harvest. Most other local agriculture is in greenhouses, and act as side projects. The produce is sold on the farm and across the country, and the farm also encourages visitors and benefits from tourism. One of the owners of the farm considers the lack of governmental support for farms as one of the greatest hurdles to farming in Iceland, especially for organic and outdoor operations.

The third interview conducted on with Icelandic farmers was on November 4, 2016, with the horticulturalist at Friðheimar, a greenhouse operation specializing in tomatoes in South Iceland. While the greenhouse would be self-sufficient with just the revenue from growing tomatoes, it also has a successful tourist operation. The farm specializes in tomatoes because they have been the most successful vegetable to grow under greenhouse lights, allowing an extended growing season. To heat their greenhouses, Friðheimar uses geothermal water pumped through pipes in the greenhouse, and geothermal and hydropower to power lights, both low-cost methods that are not available in all parts of the country. Produce from the farm is sold to a sales company in Reykjavík, which markets it to supermarkets throughout the country. A major challenge in running the greenhouse, located outside of the city center, is finding homes in the area for employees to live.

The next interviews conducted were in-person with experts on Icelandic agriculture. The first interview was conducted with Þórhildur Halldórsdóttir, who has studied the barriers to local food in Iceland that persist in the behavior of people in Iceland. In the interview, Þórhildur also identified the problems with the current system of local food in Iceland, which still requires that food travel to the capital area to be processed and then further distributed, regardless of where it was grown.

The next interview was with Ólafur Dyrmundsson, who has worked for the Farmer's Association of Iceland studying organic food. He points out that all domestically produced agriculture is considered "local" and that the average distance from the farm to the consumer is 50-100 km. The distance of food transportation is usually manageable, but can be complicated because of the uneven population distribution of the country. Still, the distance involved in domestic distribution is far more manageable and sustainable than any imported food. Despite the popularity of greenhouses, local food is still available seasonally, and imported food becomes more present in stores once local food runs out. There is potential for more food production in Iceland, but politics plays a large role in agriculture. There are also difficulties in finding breeds of crops that will grow best in the extreme environment of Iceland. To help with these challenges, Ólafur sees education as integral to expanding local production.

3.2 Importing food to Iceland

As a country, Iceland is heavily reliant on imports to sustain the national diet in almost every category of food, and imports approximately 50% of its food. A more optimistic estimate gauges that Iceland has actually produced 70% of its own food and beverages in recent years. That calculation, however, accounts for all foods processed and manufactured in Iceland, without considering the materials needed for those foods that are imported from abroad (Jóhannsson, Orri 2011). Almost all cereal grains, fruits, and oils are imported, and even most fish in stores is brought in from overseas.

In 2014, Iceland imported \$5.56 billion USD worth of goods, \$661 million of which were for food (meat and vegetable by-products, animal products, vegetables, grains and other foodstuffs). Iceland imports the most food from Denmark, at a value of \$92.7 million USD. Its second leading food import partners are Germany and the Netherlands, who export \$54.8 million and \$54.7 million USD of food goods to Iceland, respectively. Figure 1 shows that, relative to the other food products imported to Iceland from these countries, a small amount of raw vegetables are brought into the country, with processed foods, fish, and beverages comprising the majority of food imports. Fresh produce accounts for a larger portion of imports from other countries like Brazil, China, and Spain, which supply Iceland with citrus, lettuces, onions, and a variety of other fruits and vegetables, many of which are quite difficult to grow in Iceland, even with geothermal greenhouses (Simoes, Alexander 2014).

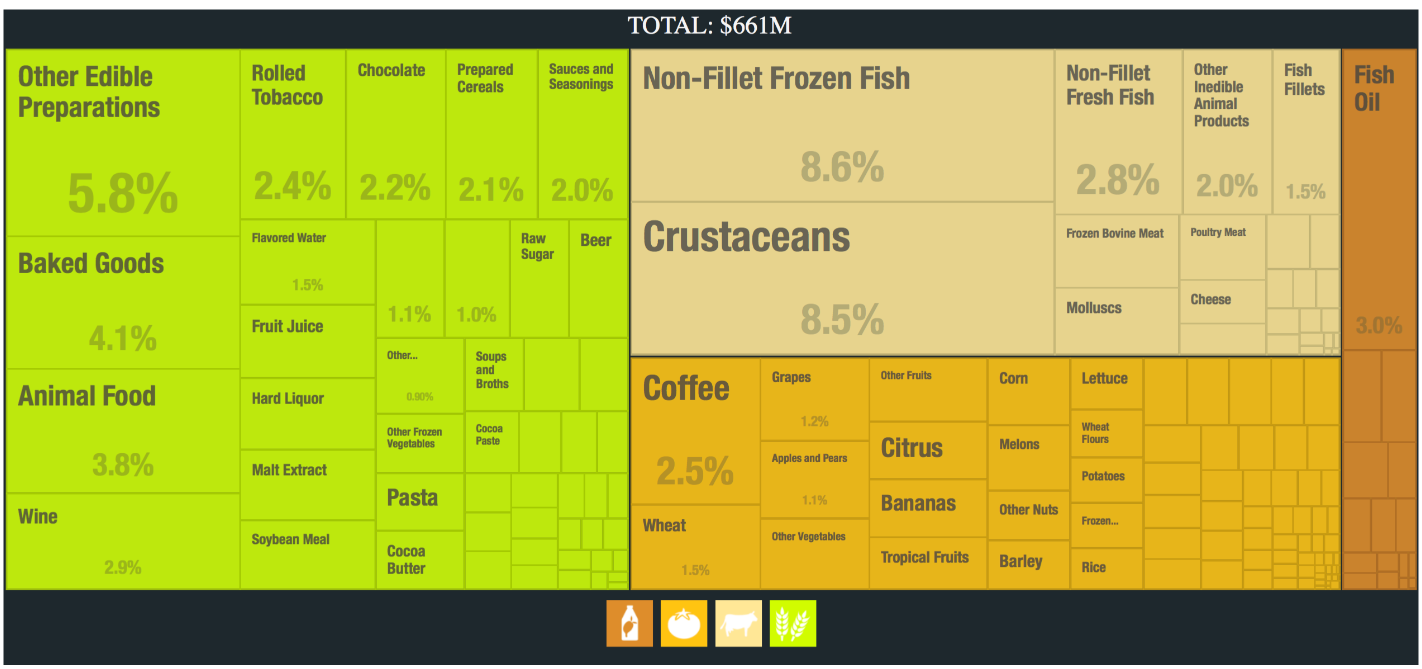

Figure 1: The composition of Iceland's major food imports in animal and vegetable bi-products (dark orange), vegetable products (light orange), animal products (taupe), and foodstuffs (green). The country imports a high amount of foodstuffs, including prepared food, and many animal products, like fish, that have been traditionally produced in country. Source: Simoes, Alexander 2014.

3.3 Local Food Production in Iceland

Despite a current reliance on imported food, Iceland has long agricultural traditions stretching back to the island's settlement, when Vikings brought over sheep, horses, and farming methods in order to sustain themselves in the harsh environment. While farming has decreased significantly as part of the national income, largely replaced by imported vegetables and processed foods, there are still strong industries that provide local food to the country. Iceland's dairy industry, for example, remains strong, providing milk, cheese, and skyr to the entire country, without need for import (Halldórsdóttir, Þórhildur Ósk 2013). Iceland's cultivation of vegetables is significantly smaller scale, and in 2008, only 1/3 of vegetables consumed in Iceland were produced in country. As seen in Figure 6, Iceland did see small gains in the amounts of vegetables produced between 1990 and 2006, especially in carrots, broccoli, tomatoes, and cucumbers (Farmer's Association of Iceland 2009). In 2011, the total yield of Icelandic vegetables was about 18,000 tons, and accounted for about 75% of tomatoes consumed in Iceland, and about 90% of cucumbers (Ragnarsson, Árni 2014).

Agriculture, and particularly vegetable cultivation, is produced unevenly throughout the country. While topography plays a role in determining the location of farms, Iceland's geothermal resources are also an important factor that has led to a large concentration of farms in the south of Iceland, where there is ready access to geothermal heat and water. Significant heating and lighting is needed to produce vegetables in a winter as harsh as Iceland's, so the cheap available heat and energy from geothermal is often quite necessary. Figure 2 shows the extent of geothermal energy throughout Iceland. Active geothermal areas can also aid in traditional outdoor agriculture, as soils are warmer in such areas (Orkustofnun). Figure 3 shows the number of farms in each region of Iceland. The south of Iceland has the largest concentration of farms, as well as the largest numbers of cattle and sheep.

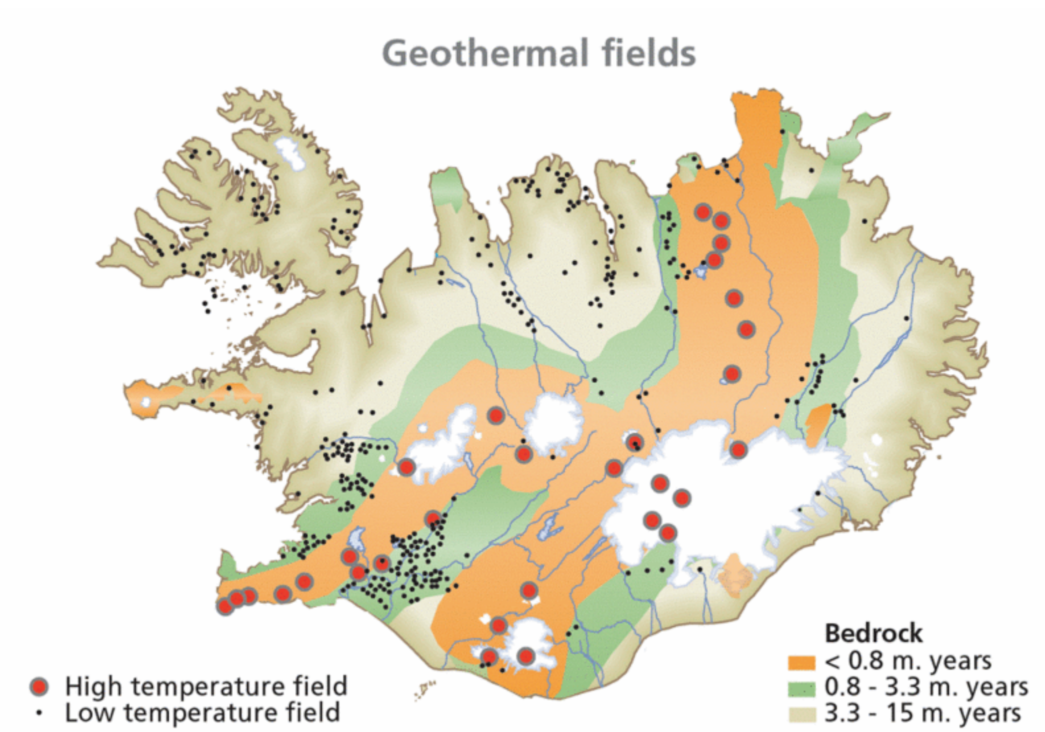

Figure 2: A map of Iceland denoting the age of bedrock, which is highly correlated to geothermal activity. The youngest bedrock (marked in orange) is the area of greatest volcanic activity, and the greatest geothermal availability. Generally, the most active geothermal area runs through the south, cutting through uninhabitable land in the middle of the country and into the north. Source: National Energy Authority, 2016

Because of the harshness of the weather in Iceland, and the availability of geothermal energy, greenhouses are popular for growing vegetables, herbs, and flowers throughout the country. In 2007, there was an estimated 194,000 m^2 of greenhouse space, and there are many who would like to increase their use in order to enhance local cultivation of vegetables in Iceland (Orkustofnun). Indeed, while geothermal areas have given rise to greenhouse villages like Hveragerði, and a concentration of big-name greenhouses like Friðheimar and Solheimar Eco-Village in South Iceland, where readily available hot water is used to heat the crops easily, greenhouses are also easily found in places like the East of the country, where access to low or high-temperature fields is far more limited (Figure 2).

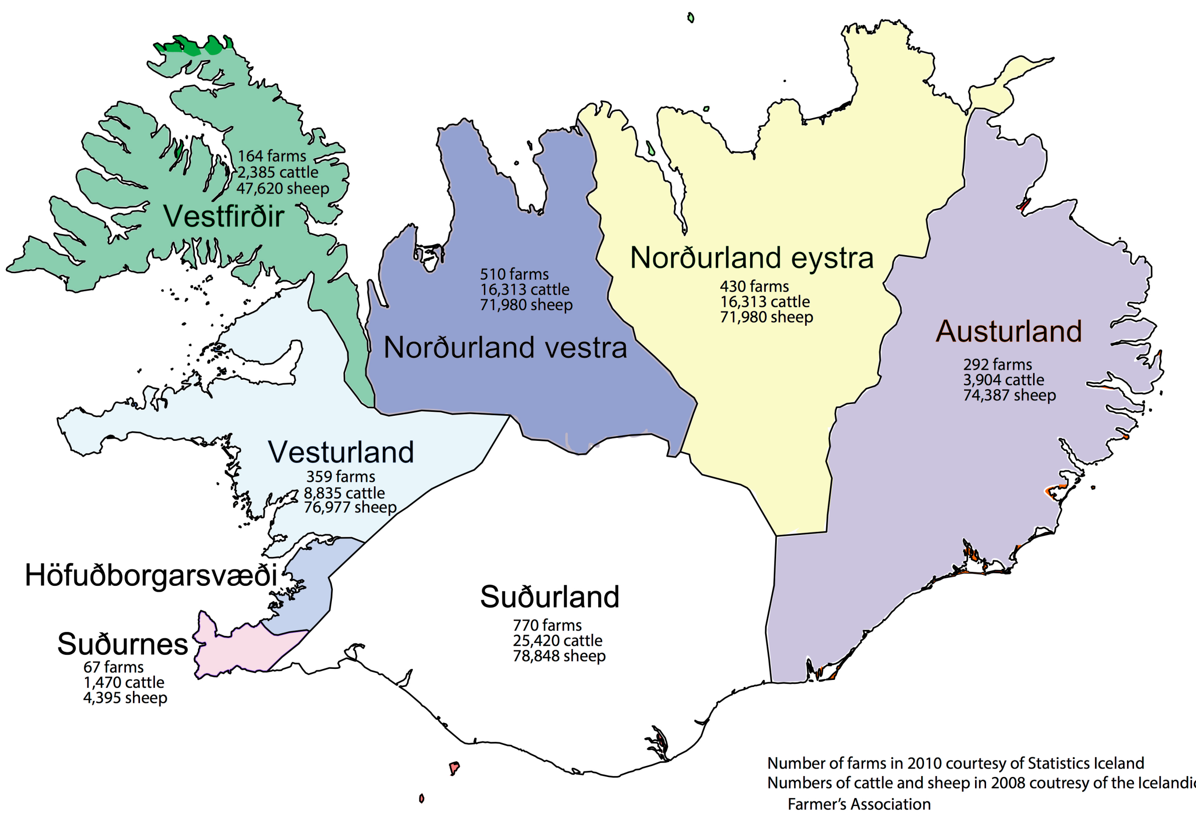

Figure 3: The concentration of Icelandic farms by region. The highest concentration of farms is in the south of the country. Sources: Statistics Iceland 2010; Icelandic Farmer's Association 2009; NordNordWest (Wikimedia Commons) 2008.

Farmers use a variety of other agricultural techniques to combat the difficulties of farming vegetables in Iceland. Besides using heating and lighting in greenhouses, many also use fertilizers, often a mix of both imported and domestic, and soils that are largely imported from afar (Butrico, Gina Marie 2013). Successful outdoor farming operations in Iceland rely heavily on choosing crops that will grow successfully on the land available, and sheep and potato farms are quite popular because those products have been successful in Iceland, and have a long history of cultivation in the country.

These methods of farming vegetables are used extensively to cope with the difficulties of growing food in a landscape and climate as harsh as Iceland's. While warm ocean currents allow the island to enjoy warmer weather than other areas at the same latitude, Iceland still suffers from cold temperatures, high winds, and almost constant darkness during the long winter season. This makes the growing season short, limiting the kinds of crops that can be cultivated, and increasing the cost of greenhouses. Factors like high winds also play a role in deciding what crops can be grown. Iceland must import much of its grain supply, because high winds can often blow seeds from cereals like barley, scattering them before they can be harvested. To work around these challenges, farmers must choose from already limited land to find the perfect spot to cultivate goods they would like to produce.

While the local food movement in Iceland suffers from the difficulty of producing food, there are additional difficulties that make selling local food difficult. Icelandic produce, while available at most major grocery stores, must compete against imported products. Local vegetables are also more seasonal than those imported. After peak harvest times, local food will be replaced by more abundant and varied imported produce.

Getting local food to consumers in Iceland also involves a significant amount of transportation. While the island of Iceland is relatively small, the population is unevenly distributed, with about half of the population living in the capital area around Reykjavík (Central Intelligence Agency 2016). Difficult terrain often makes transportation between towns indirect and slow. In addition, much of the local food in Iceland must be packaged and processed, which means transportation to food processing plants, most of which are concentrated in the capital region, before distribution to grocery stores around the country. In this system, a piece of food could travel from a farm, across the country to a processing plant, and back across Iceland before being sold. Table 1 shows the amount of CO_2 that is released from the transportation of foods the distance between Reykjavík, where most food processing occurs, to major cities in each region of Iceland. Depending on where food is produced in Iceland, and where it is later distributed, it may travel across the country more than once.

Table 1: Emissions from road transportation from Reykjavík to Icelandic cities

Destination from Reykjavík	Emissions factor g/km	Distance traveled (km)	Emissions (metric tons)
Selfoss	1055.7	52	0.0549
Höfn	1055.7	451	0.4761
Akureyri	1055.7	380	0.4012
Ísafjörður	1055.7	446	0.4708
Seyðisfjörður	1055.7	671	0.7084
Vík	1055.7	180	0.1900
Húsavík	1055.7	472	0.4983

3.4 Emissions related to local food

The transportation involved in local food processing and distribution contributes to the overall emissions cost of growing vegetables in Iceland, but there are many other areas where agriculture emits CO_2. For vegetables grown in Icelandic greenhouses, for example, there area many materials needed for building and maintaining the greenhouses that are typically imported to Iceland. These materials include glass and other building components, soils, and fertilizers. Energy is also required for heating the greenhouses and running lights throughout the winter, as well as the aforementioned transportation to processing plants, and then to the consumer. Figure 4 describes these necessities and the estimated emissions related to them. Some of these components of Icelandic vegetable production do necessarily emit significant CO_2 because of local solutions that improve energy efficiency. For example, geothermal reserves diminish emissions related to heating and lighting because it is a renewable energy source.

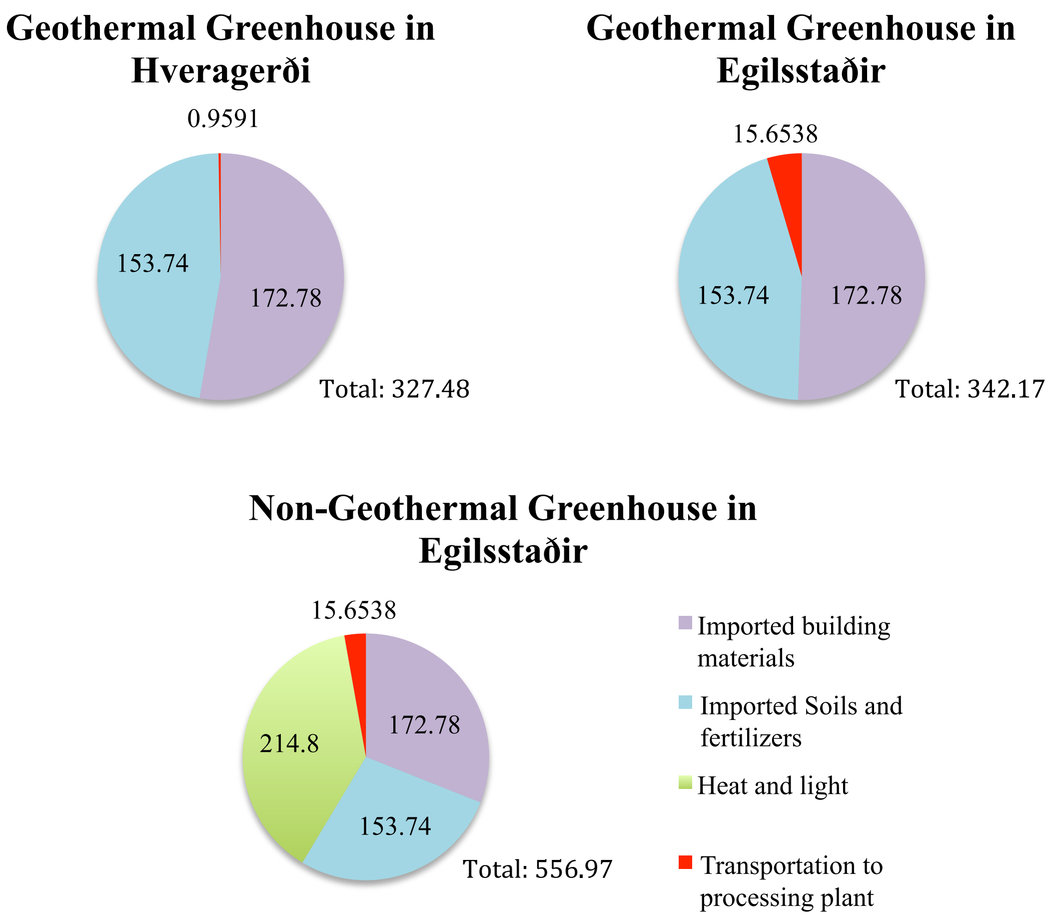

Figure 4: Estimated yearly CO_2 emissions values (metric tons) related to different farm operations for farms in the South or West of Iceland, using electricity and heat derived from geothermal or oil energy. These estimates assume 23 food shipments per year to processing plants, one shipment of building materials, and one shipment of fertilizers and soils.

In places without geothermal potential, other energy resources must be used. Often in Iceland, hydropower is readily available as another low-emission energy source. In some areas, however, oil is the least expensive form of energy. In Figure 4, greenhouses using geothermal energy and heat are assumed to have zero carbon emissions in that sector. For greenhouses without geothermal, it is assumed that oil is used to power the functions of the greenhouse. While many greenhouses without geothermal use hydropower, which has is a low-emission energy source, the table shows the extremes of efficiency and inefficiency in energy, with a range of emissions scenarios in between.

While the amount of CO_2 related to building material and fertilizer imports is estimated to stay constant regardless of a greenhouse's location, the distance from processing plants and the available energy source play a large role in determining the relative efficiency of greenhouses in different areas of Iceland. Because of the availability of geothermal energy in Hveragerði in southern Iceland, there is little reason to use energy other than geothermal, unlike in Eastern Iceland, where geothermal availability is scarcer, and farms may look to other energy sources.

3.5 Emissions related to imported food

Food that is imported to Iceland from abroad emits CO_2 in the same areas, but the different situations in which is it produced and transported emit CO_2 in far different amounts. Many of Iceland's top import partners are countries with warmer climates and strong food industries. Table 2 shows the top import partners for food coming to Iceland (Simoes, Alexander 2014). While horticulture in these different areas demands a variety of resources and amounts of energy met by varying sources, there are also vast differences in the distances products must travel to get to Iceland. Once in Iceland, these goods must then be distributed to grocers throughout the country, taking the paths described in Table 1.

Table 2: CO_2 Emissions from shipping from major Icelandic import partners to Reykjavík

2.1: *Refrigerated cargo*

Origin	Emissions factor refrigerated (g/TEU km)	Distance travelled (km)	TEU	CO_2 refrigerated (metric tons)
Norway (Oslo)	130	2602	724	244.90
Denmark (Gulfhavn)	130	2841	724	267.39
Germany (Buetzfleth)	130	2728	724	256.76
UK (Felixstowe)	130	2528	724	237.94
Netherlands (Rotterdam)	130	2698	724	253.94
USA (New York)	105.6	5519	724	421.95
China (Shanghai)	69.6	23785	724	1198.54
Brazil (Santos)	88	12012	724	765.31
Spain (Valencia)	130	5347	724	503.26

2.2: *Dry cargo*

Origin	Emissions factor dry (g/TEU km)	Distance travelled (km)	TEU	CO_2 dry (metric tons)
Norway (Oslo)	84	2602	724	158.24
Denmark (Gulfhavn)	84	2841	724	172.78
Germany (Buetzfleth)	84	2728	724	165.91
UK (Felixstowe)	84	2528	724	153.74
Netherlands (Rotterdam)	84	2698	724	164.08
USA (New York)	70.3	5519	724	280.90
China (Shanghai)	37.9	23785	724	652.65
Brazil (Santos)	52.9	12012	724	460.05
Spain (Valencia)	84	5347	724	325.18

Table 3 makes similar estimates for goods imported to Iceland, factoring the emissions related to farming in other countries. This gives a holistic estimate of emissions related to foreign vegetables imported to Iceland.

Table 3: Estimated emissions of horticulture imported from major trade partners

3.1: *30% CO2 emissions*

Location	Farming Emissions	Overseas transport emissions	Total emissions
Norway (Oslo)	134.87	201.57	336.44
Denmark (Gulfhavn)	134.87	220.09	354.96
Germany (Buetzfleth)	134.87	211.33	346.20
UK (Felixstowe)	134.87	195.84	330.71
Netherlands (Rotterdam)	134.87	209.01	343.88
USA (New York)	134.87	351.43	486.30
China (Shanghai)	134.87	925.59	1060.47
Brazil (Santos)	134.87	612.68	747.55
Spain (Valencia)	134.87	414.22	549.09

3.2: *50% CO2 emissions*

Location	Farming Emissions	Overseas transport emissions	Total emissions
Norway (Oslo)	224.79	201.57	426.36
Denmark (Gulfhavn)	224.79	220.09	444.87
Germany (Buetzfleth)	224.79	211.33	436.12
UK (Felixstowe)	224.79	195.84	420.63
Netherlands (Rotterdam)	224.79	209.01	433.80
USA (New York)	224.79	351.43	576.21
China (Shanghai)	224.79	925.59	1150.38
Brazil (Santos)	224.79	612.68	837.47
Spain (Valencia)	224.79	414.22	639.01

3.3: *70% CO2 Emissions*

Location	Farming Emissions	Overseas transport emissions	Total emissions
Norway (Oslo)	314.70	201.57	516.27
Denmark (Gulfhavn)	314.70	220.09	534.79
Germany (Buetzfleth)	314.70	211.33	526.03
UK (Felixstowe)	314.70	195.84	510.54
Netherlands (Rotterdam)	314.70	209.01	523.71
USA (New York)	314.70	351.43	666.13
China (Shanghai)	314.70	925.59	1240.29
Brazil (Santos)	314.70	612.68	927.38
Spain (Valencia)	314.70	414.22	728.92

4. Discussion

4.1 Comparative emissions of imported and local food in Iceland

While the estimates presented for the CO_2 emissions related to food produced in and brought to Iceland are inexact, they nonetheless show the vast difference in energy required for imported horticulture in comparison to locally grown vegetables. Even when the estimate of emissions for growing foreign vegetables is estimated to produce only 30% of the CO_2 emissions of Icelandic produce, the CO_2 released through shipping the food results in an almost equal, and in some cases, greater amount of emissions by the time the produce reaches an Icelandic grocery store (Table 3).

It is also important to remember that the amount of CO_2 released in a shipment that factors into this calculation only accounts for one shipment in an entire year. It is unlikely that only one shipment of food per year would be made, so the estimates are almost certainly conservative.

By comparing the total emissions from local food production and distribution in Iceland to the emissions from importing food produced overseas, it is clear that local food has a lower carbon footprint. Many of the highest-emission aspects of producing food in Iceland are one-time or once-a-year costs, like building and maintenance material, and importing fertilizers. When these costs are removed, the regular costs of a greenhouse's energy needs and produce transportation are much smaller.

The availability of low-cost, low-emission heating through geothermal power is a large factor in keeping emissions down. Many farmers cite the cost of electricity as their major expense in greenhouse agriculture, but the low cost of energy in Iceland from renewables like hydropower and geothermal aids considerably in lowering the cost, and the emissions from farm operations. This has led to the concentration of farming around geothermal areas in the country, particularly in the south, where almost 30% of farms in Iceland are located (Statistics Iceland, 2010).

This puts a large portion of Icelandic farms close to processing plants, lowering the distance the food must travel to be processed. Because about half of the population of Iceland lives in the capital area, a majority of the food is distributed close to the processing centers (Central Intelligence Agency 2016). For the approximately 50% of the country that does not live in the capital region, the distance to transport processed food can add greatly to transportation emissions in an item's journey. From Reykjavík to the areas named in Table 1, food must travel regularly. There is a long, high-emissions journey involved for vegetables grown far from processing plants and then transported back to their area of origin.

While the transportation of food within Iceland plays a role in the country's fossil fuel emissions, it is a far smaller contributor than the vessels that bring food to Iceland from elsewhere. Any food brought into the country must be carried over two thousand kilometers by boat or plane, which emit significant amounts of CO_2 on every trip, contributing to high greenhouse gas levels that perpetuate to global climate change. The amount of CO_2 emitted on a trip from one of Iceland's major importers to Reykjavík increases when the shipments carry refrigerated loads, necessary for many fresh foods.

4.2 Local sustainability, local security

Locally sustainable food systems in Iceland are important in order to limit the continuation of climate change from adding CO_2 to the atmosphere from food transportation, but also because they increase local food security. Iceland's transport-heavy food system can be easily disrupted by a number of factors, including natural disasters, bad weather, and world market events, cutting the lines between food distributors and consumers. The common practice of importing farming material from abroad also contributes to this insecurity. These habits are widespread, and lower the overall sustainability of farming in Iceland and threaten the independence of Icelandic farmers from delicate world markets because of the dependence on imported material necessary for farming.

While Iceland enjoys well-established import partnerships that allow for strong lines of food and farming supply shipments, there are many factors that threaten food security in the country because of the reliance on imported goods. Despite Iceland's currently strong economy, economic uncertainty has been a very present threat in the past. In the aftermath of the 2008 global financial crash and the subsequent collapse of the value of the Icelandic kroner, foreign suppliers and shipping companies refused to do business with Iceland, afraid they would loose money by dealing with such a fragile economy. While this was soon settled and trade was quickly re-established, the temporary break in supply led to a limited availability of diverse food options, and also served as a warning to the dangers of an import-reliant food industry. Another wake-up call was served by the 2010 eruption of the volcano Eyjafjallajökull, which spewed large amounts of ash, limiting air travel, burying crops, and leading to delays of imported goods and failures in domestic food transport and distribution (Butrico, Gina Marie 2013; Jóhannsson, Orri 2011). These events brought to center stage the fragility of a transport-dependent food system, where areas that lacked local food infrastructure were very quickly facing food shortages in stores. Weaknesses were identified both in the national reliance on imported goods, but also on the fragile lanes of distribution within the country, moving food from farmer to processor to consumer.

4.3 Climate change and the food system

With the continuation of global climate change, these disruptive events are likely to become more unpredictable and intense, which can threaten the security of food supplies. The effects of climate change are likely to disrupt both the production and the distribution of food in Iceland. As biologists Hamilton, Brown, and Rasmussen explain in their work on Greenlandic fisheries, climate change can drastically change the limits of sustainability, as they are currently defined (2003). This holds true around the world, especially in relation to food production. Because of climate changes, the earth systems upon which food production networks are built will change, altering the success of different crop species in ways that are not yet fully realized. Because of the importance of food, it is integral that the possible threats to food systems are understood before investments are made in infrastructure that may not be sustainable in a new world defined by global climate change.

As an area that is particularly sensitive to the symptoms of global climate change, the arctic is already feeling some of its effects. As Figure 5 shows, overall, temperatures in the arctic are increasing. In Iceland, climate change is expected to warm the local climate, increase rainfall and the risk of flooding, and change wind patterns, with more tempests and gusts expected. These hazards threaten agriculture in Iceland by flooding crops and blowing seeds from grains before harvest. Despite this, there are still widely held-beliefs that climate change will have an overall positive effect on agriculture in Iceland (Jóhannsson, Orri 2011).

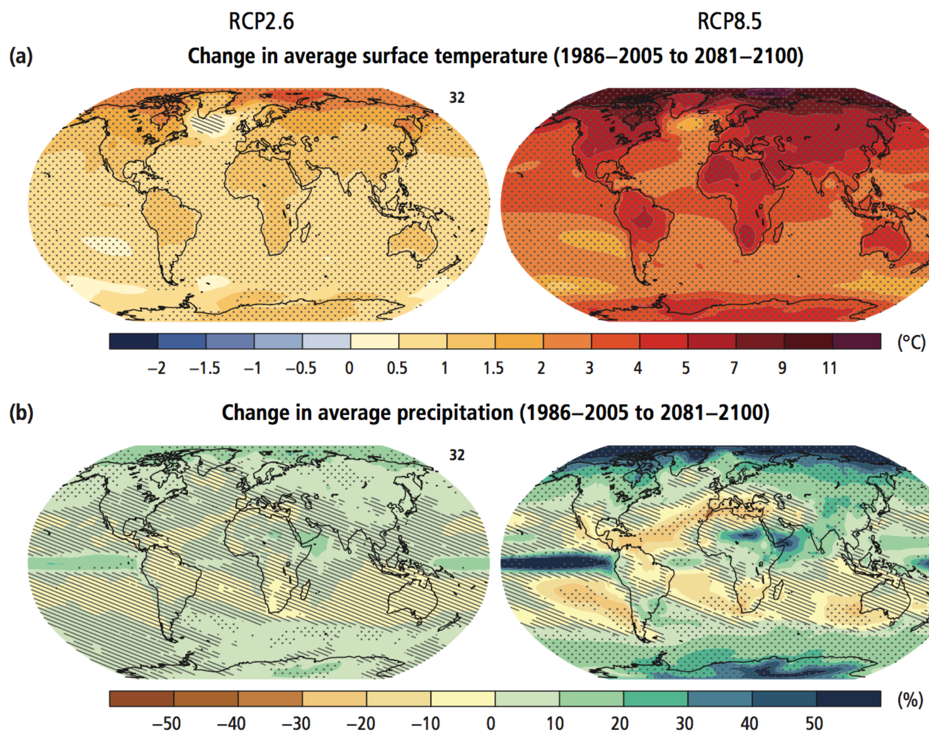

Figure 5: (a) Change in surface area and (b) change in annual precipitation globally based on the mean projections of numerous models for 2081-2100 relative to 1986-2005. The number of models used for each panel is indicated in the upper right of each section. The left side projects change based on Representative Concentration Pathways (RCP) 2.6 (low-emissions scenario), and the right side indicates RCP8.5 (high-emissions scenario). In both cases, the arctic experiences more intense warming and precipitation change relative to the rest of the globe. *Source: IPCC 2014.*

In remote areas of the arctic, issues in food distribution must also be considered with the threats of climate change to food security. Because most food brought to the arctic is transported by boat or plane, it is important that weather patterns stay stable enough for these shipments to continue regularly. With climate change, however, comes changes in storm patterns and sea ice extent, which can affect both sea and air transport. In terms of sea ice, climate warming is projected by many to favor artic shipping, rather than inhibit it. Some experts, however, consider this overly optimistic. While sea ice extent is decreasing around the arctic, there is still enough multi- and first-year ice present to pose threats to ships in arctic lanes like the Northwest Passage. As sea ice continues to melt, there are also worries that ice will become more mobile, and pose a wider threat to arctic shipping routes for many years (Haas, C. 2015). Climate change will not necessarily make shipping easier, and there will still be threats to shipments by sea, but climate changes may give rise to new, less-understood threats.

Air shipping, while not affected by sea ice extent changes, is threatened by many of the other possible effects of climate change in the arctic and around the world. Temperature changes, increases in flooding from changing precipitation patterns, and sea level rise threaten air transport infrastructure worldwide. These threats vary and may not be as pressing in the arctic as they are elsewhere. Changes in extreme weather, local weather, and the jet stream have the opportunity to disrupt aviation supply chains in the arctic and globally (EUROCONTROL 2014). Increases in storms and changes to regular weather patterns may increase the difficulty of food transportation to remote areas with climates that already challenge transportation. Shipping and aviation as methods of import are the major pathways to food for Iceland, making concerns for climate change of the utmost importance.

In addition to the challenges posed to food transportation by air and boat, the effects of transportation upon the climate must be considered. The aviation industry has contributed an increasing amount of CO_2 to the atmosphere, intensifying radiative forcing within the atmosphere, and advancing anthropogenic climate change. These effects are projected to continue, and air traffic is predicted to double every 15 years as the industry continues to expand. Without cutting emissions from aviation, the amount of CO_2 injected into the atmosphere from planes will continue to increase rapidly (Lee, David S. 2009). Shipping by sea releases emissions that can initially cause cooling, but in the long run, the CO_2 released in shipping can aid in global temperature increases (Berntsen, T. 2008). The continuation of importing food from far away carries on the cycle of climate change, and limiting long-distance shipping could play a key role in cutting CO_2 emissions being added to the atmosphere.

4.4 Overcoming challenges in local food

While research shows that there are many benefits to local production over import-reliant food systems, growing vegetables in Iceland can be an uphill battle. Topography, climate, and limited sunlight have all been mentioned as roadblocks to agriculture, and particularly to growing vegetables in Iceland. Despite this, there are estimates that Icelandic agriculture is underutilized for what it can produce, even in the face of such challenges (Halldórsdóttir, Þórhildur Ósk 2013). As of 2009, only 1.3% of the country was cultivated land (Farmer's Association of Iceland 2009). Although much of the country is covered by glaciers, steep fjords, and lava flows that make the land unsuitable for cultivation, estimates indicate that, if all arable land was cultivated, cereal production needs could be met for Iceland through in-country farming alone (Halldórsdóttir, Þórhildur Ósk 2013).

There are some farms that have found success despite the challenges of the area, adding Icelandic produce to markets that are flooded with imported goods. Móðir Jörð is an outdoor organic farm in Eastern Iceland that specializes in grains, with a focus on barley, despite the difficulties in production. Located in a valley ringed by forests, the trees act as a wind block, allowing the grains to grow with little disruption. The farm also utilizes agroecology, allowing crops to grow next to each other in ways that create mutually favorable environments. This helps to exploit the benefits each crop has on the land, and utilizes the land in the most efficient way, allowing them to produce up to 100 tons of barley per year, along with 80-100 different varieties of potatoes, lettuce, cereals, herbs, and cabbage.

Friðheimar is another farm that has found success in Iceland, using greenhouses and available geothermal energy to cope with difficulties. The horticulturalist from Friðheimar was interviewed to learn more about local farming practices in geothermal areas of Iceland. Friðheimar is located in the south of Iceland, in an area with ready geothermal reserves, and uses water from a hot spring at the farm to heat the greenhouse. The farm cultivates tomatoes, because they respond the best to the artificial lights used in the winter. Friðheimar has found success by adapting their cultivation methods to fit the resources available, and produces about one ton of tomatoes a day.

There are many modern farming methods that can best exploit the available resources for continued sustainable farming that are being used throughout the arctic to boost local agriculture. In her address to the 9th annual Circumpolar Agriculture Conference, Lene Lange introduced the importance of microbial enzymes to adapting thin polar soils to farming. These enzymes can enrich the soil and allow plants to grow better. Because some plants respond better to different enzymes, more research on useful enzymes for growing major crops in the arctic would allow for the expansion of agriculture in the arctic with more successful yields. Microbes can also be used to protect against the negative effects of climate change. Microbes can help plants resist drought, and can act as buffers against fluctuations in temperature and other climate variables (2016).

In addition to utilizing microbial enzymes to make soils more hospitable to non-native crops, breeding plants to withstand harsh arctic conditions is an effective way to increase sustainability and useable crop yields. In Iceland, crops that can grow to maturity in the short but intense summer, withstand colder temperatures, and tolerate strong wind gusts are favorable. Finding these characteristics in grains is particularly difficult but important, as finding suitable areas with wind blocks is quite challenging. Breeding shorter barley varieties that can be more successfully shielded from wind has been successful, as barley is a grain that otherwise does well at higher latitudes.

4.5 Imported and domestic food in Iceland

Despite the local successes of Icelandic agriculture and the potential for more, food imports to Iceland in all categories remain strong. In 2008, while other agricultural products were imported on a much smaller scale, 2/3 of vegetables consumed in Iceland were imported, even as Icelandic vegetable production grew modestly in almost all major crops, described in Figure 6 (Farmer's Association of Iceland 2009). Still, as shown in

Figure 1, vegetable products account for approximately 144 million USD, or 22% of the total value of imported food products (Simoes, Alexander 2014).

Vegetable and horticultural production in tons*

	1990	1995	2000	2005	2006	2007
Potatoes	14,893	7,324	9,013	7,250	13,800	13,000
Turnips	808	328	793	750	800	860
Carrots	231	395	395	418	398	526
Cauliflower	95	122	89	44	83	112
Cabbage	395	624	538	346	307	340
Broccoli		25	53		56	83
Chinese cabbage	224	301	255	162	219	222
Red cabbage					32	
Lettuce		40			66	90
Leek		22	22		6,0	0
Tomatoes	495	749	931	1,508	1,724	1,603
Cucumbers	534	606	914	1,147	1,124	1,343
Sweet peppers	120	194	203	126	130	147
Mushrooms		251	447	438	488	515

Sources: Association of Horticultural Producers, official stock reports for potatoes. Direct sales from greenhouses estiamted at 2%. Devitations in outdoor crops are 5%.

*Published with reservations, some figures estimated.

Figure 6: Production of major crops in Iceland between 1990 and 2007. Source: The Farmer's Associate of Iceland 2009.

Many other food imports come in the form of prepared foods, drinks, sugars, baked goods, and fish (Simoes, Alexander 2014). While some of these products could theoretically be produced in Iceland, a majority of the imports to the island require ingredients that cannot be grown in the Icelandic climate, or machinery that cannot economically be brought over, making it more plausible to import. Advances in farming technology may open the doors to increased domestic production for some of these products, including juices and grain-based goods, and a re-allocation of Icelandic fish to local markets would decrease the need for imported fish, but there will still be many products that cannot be produced locally.

Relying only on what can be locally produced would mean a sharp decline in variety in the Icelandic diet, which is a sacrifice few people on the island would be likely to make. Increasing Icelandic agriculture to its maximum potential could, however, drastically decrease the variety and amount of products that must be imported, and replace many imported goods with locally grown and processed competitors. Increasing grain production, for example, would decrease the dependence on imported grains for baked goods and flour sales. New innovations in selective breeding of shorter-stemmed grains that withstand harsh winds are promising for increasing the amount of domestically produced grains and grain products. With the continuing growth of greenhouses in Iceland, there is increased potential for vegetable production throughout the country. While the topography is indeed limiting to the amount of farming that can occur on the island, utilizing the full potential of Icelandic agriculture would significantly decrease the dependence on imported vegetables, especially with produce that can be easily harvested in Iceland.

Fish are another food product that can be farmed in Iceland as a way to limit food imports. While fish is a major part of the traditional Icelandic diet, the fishing industry in Iceland has transitioned to become export-oriented, leaving little for domestic markets.

Still, fish continues to be an important part of the Icelandic diet, and a majority of supply needs are met by foreign imports (Halldórsdóttir, Þórhildur Ósk 2013). Placing a larger focus on local fishing with sustainable methods would help cut down on the amount of fish imported from abroad, at least for varieties that can be caught in Iceland, like cod and arctic char, which have been growing in production, and salmon and rainbow trout (Farmer's Association of Iceland 2009).

4.6 Increasing sustainability and security in-country

While maximizing the potential of local vegetable farming in Iceland and decreasing the amount of imported vegetables in Iceland can greatly increase the sustainability and security of the food system, improvements can also be made at the local level. Cutting down on import reliance and intensity increases sustainability by limiting major energy-intensive transportation, and security by moving away from markets that are vulnerable to global economic and environmental disasters. These threats, while smaller scale, are still active in national food systems, and can affect local food as well. To minimize the emissions and fragility of local food, changes to food production, transport, and processing can be made on all levels.

There are changes in farming practices that can be made to farms around the country that can increase the sustainability of their operations, like the use of domestically produced soils and fertilizers. Despite the availability of local fertilizers, importing manure and other materials is quite popular in Icelandic farming. Iceland has local solutions to this, and expanding the use of locally produced fertilizers like fishmeal can limit the number of imported goods needed for agriculture on the island, decreasing the greenhouse gas emissions related to farming. Phasing out other imported farming products in favor of local products can continue to limit greenhouse gas emissions from imported agricultural materials. Soils and fertilizer can be produced from local compost and volcanic ash, as well as human waste, which would simultaneously help dispose of waste in a sustainable manner. Greenhouses can also successfully utilize hydroponics, a method that diminishes the need for topsoil, or stonewool, which, while imported, can also be utilized as a more sustainable option to imported topsoil (Butrico, Gina Marie 2013).

In order to cut down on transportation between farms, processing plants, and stores, investments can be made for processing plants that can locally serve more remote areas within the country. This becomes more viable if in-country agriculture increases, because investments in more processing would be necessary to serve the increased amount of food moving through. By allowing food to be processed locally, needless transportation would be removed from its path from farm to consumer, especially if the processing plants in the capital area are removed from the path of the food.

These innovations towards food sustainability also move towards increased food security. By limiting total distance between the farm and consumers, Iceland can protect itself from disasters that block domestic food distribution. These disruptions, as seen in Iceland's recent history, can cause major problems in food movement to and around Iceland, causing food shortages within the country.

Disruptions to food growth and transportation are likely to increase with the continuation of climate change in Iceland. In the same ways that changes in weather patterns can affect overseas food transportation, the floods and winds expected in Iceland from global climate change can wreak havoc upon in-country transportation (EUROCONTROL 2014; Jóhannsson, Orri 2011). Localizing food as much as possible would minimize the risks related to these disasters, should they disrupt cross-country road transportation. In the event of delayed food shipments from across the country, communities would have their own local resources. While climate change may not immediately increase the frequency of these disasters necessitating strengthened lines of food transportation, these considerations must be made as climate change continues to quickly change arctic climate and weather systems, making these events more likely.

5. Conclusion

While this study focused specifically on Icelandic agriculture and food systems, many of the struggles in farming, sustainability, and food security that are found in Iceland hold true for the larger arctic area. In order to increase the sustainability and security of food in Iceland, the wider arctic area, and elsewhere, there must be work against the current trend of globalization and an increased focus on using as many local materials and foods as possible. In Iceland, this means expanding in-country agricultural production in a way that best utilizes geothermal availability, local fertilizers, plants that are successful in cold environments and greenhouses, and microbes that create more favorable living environments for crops, among other practices. By increasing local production of fresh products that can be grown locally and efficiently, arctic countries can cut down on their reliance on imported food, which carries a heavy emissions cost and is prone to a number of natural disasters, market fluctuations, and world events that can disrupt distribution and make food scarce and expensive.

In order for these changes to become reality in Iceland, increased institutional support from the government is necessary. Currently, many farmers cite lack of government support as the largest hurdle to farming in Iceland. Subsidies to farmers are small, and there is a lack of support when disasters happen and damage farm systems. In order to encourage farming in Iceland, these problems must be addressed, so farming can be a viable lifestyle for more people. This includes raising subsidies to farmers, which have been drastically cut since 2002, and largely fund electricity, often the most expensive part of a farming operation. Expanding tariffs on imported vegetables to protect greenhouse agriculture would also help Icelandic farms compete with foreign markets (Butrico, Gina Marie 2013). Additionally, as Iceland continues contemplating joining the European Union (EU), the interests of farmers must be considered heavily. Joining the EU could be disastrous for Icelandic agriculture markets, as lowered prices and increased ease of access to continental European goods would quickly out-compete local produce.

The steps Iceland must take in order to increase the food sustainability and security of the country can be applied throughout the arctic, with local adjustments. In many remote corners of the arctic, where traditional local food is threatened by climate change, and there is growing reliance on imported food, these changes towards local production are pressingly necessary. In many areas, increased support may be the first step towards investments in sustainable farming techniques. Support in implementing the use of greenhouses, microbial enzymes, and plant breeding, some of the more difficult methods to commence, can lead to efficient growth systems that can be shaped and maintained by the community to provide them with the foods they want and need the most. Some of the same methods recommended for Iceland, like using local fertilizers and materials in agriculture, can be easily implemented in both new and established greenhouses and farms. Other methods, like the use of geothermal water for heating, may be more difficult or impossible, and require local redesigns to utilize the resources available. For example, heating and lighting systems in greenhouses must be powered by renewable energy systems that work locally, which can be a challenge to establish in many areas.

While many of these problems have been developing for decades, solutions to inefficient and insecure food systems have never been more important in the arctic in the face of rapid climate change. In Iceland, innovations in technology paired with increased investments in farming can grow local agriculture and increase the independence of Iceland's food system. Despite challenges, arctic countries have the opportunity to develop groundbreaking sustainable agriculture plans, and in order to cope with the effects of global climate change, these innovations may be necessary to future life in the arctic.

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Appendix I: Ethical procedures

SIT Study Abroad
School for International Training

APPLICATION FOR HUMAN SUBJECTS REVIEW

The researcher has the primary responsibility to ensure safe research design and to protect human participants from all types of harm. Research that exposes human subjects to the risk of unreasonable harm shall not be conducted.

The Local Review Board (LRB) has the primary responsibility for determining whether the proposed research design exposes subjects to a risk of harm. If there is still uncertainty after the review, the Academic Director may solicit a full SIT Institutional Review Board (IRB).

Please read the following carefully, complete the attached form, and sign this agreement. Do **NOT** begin your research (including contacting potential research participants) until you are notified that your application has been approved.

Student Name Molly Peek

Phone 646-280-9414

Email mpeek@smith.edu

SIT Study Abroad Program Iceland and Greenland: Climate Change in the Arctic

ISP advisor's Name Paul Wetzel

ISP advisor's contact (phone and email) pwetzel@smith.edu

Title of ISP: What is the taste of CO2? The sustainability of Iceland's food in the face of global climate change

ISP Site(s): Reykjavík, Iceland

1. Brief description of the proposed project:
This project will study the sustainability of food production in Iceland, using phone and in-person interviews to ask farmers and other Icelanders about how food is produced and transported, and the energy used to make both happen.

2. Data Collection: Brief description of human subjects' role in proposed research:
   a. Please indicate the number of participants by age and gender:

      1) ____ Children (under 18 years of age)
      2) __7__ Adults (over 18 years of age)
   b. Does the study involve any vulnerable populations? If yes, please explain.
      No

c. What are other relevant characteristics of participants including (but not limited to) institutional affiliation if any?

Most are farmers or work for shipping companies or organizations that oversee food production and distribution in Iceland.

d. If there is a cooperative institution, how was the institution's permission obtained?

No cooperative institution

e. What will participants be asked to do and/or what information will be gathered? (**Append copies of instructions, survey instruments, etc.**)

Participants will be asked to talk through their growing methods including fertilizer, pollination, hydration, and greenhouse structure and power, as well as their agricultural yields. They will also be asked to talk about their perception of food production in Iceland.

f. If participants are interviewed, will you conduct the interview yourself and, if not, who will? In what language(s) will participants be interviewed? Where will these interviews take place?

I will be conducting the interviews in English. The interviews will take place over the phone or in the work places of the interview subjects.

g. How many meetings will you hold with participants? (Will it become a burden to the participants of the research?)

The interviews will be conducted in one session, with one more extra session if necessary and agreed upon by both parties.

h. Do participants risk any stress or harm by participating in this research? If so, why is this necessary? How will these issues be addressed? What safeguards will minimize the risks?

There is no risk of stress or harm in these interviews.

i. How are participants recruited?

Based on publication of their farms and information on the internet, or by in-person and email meetings.

j. How will you explain the research to participants and obtain their informed consent to participate?

This study is meant to calculate the environmental cost of the current food production and importation systems in Iceland with the goal to create a plan of maximum efficiency and security for food in Iceland.

k. If participants are minors or not competent to provide consent, how will it be obtained?

There is no plan to interview minors, but consent would be obtained by talking to both the interviewee and their direct guardian.

l. How will participants be informed that they can refuse to participate in aspects of the study or may terminate participation whenever they please?

I will inform them of this right as I explain the purpose of the interview.

m. How will you protect participants from feeling pressured to participate in the study due to any power differential?

I will ask them of their comfort with the questions, and conduct interviews in places where they feel comfortable.

n. How might participation in this study benefit participants?

The will be able to participate in work relevant to their lives, as well as understand where they stand in the food systems of Iceland.

o. Will participants receive a summary of results or a copy of the ISP?

Yes, if they would like one. I will ask during the interview if they would like an emailed copy.

p. Are participants compensated in some form?

No

3. How will the following be protected?

a. Privacy (protecting information about participants): Refers to an individual and their investment in controlling access to information about themselves.

I will show interviewees the citation method I will use, and ask if they would like any of the information removed.

b. Anonymity (protecting names and other unique identifiers of participants): Names should not be attached to the data, unless the subject chooses to be identified.

I will ask the subject how they would like to be identified, or if they would like to be named in the text.

c. **Confidentiality** (protecting data about participants): How is access to data limited? How data will be stored and for how long? Will it be used in the future and, if so, how permission for further use will be obtained? Will your ISP paper be accessible online?

Data is limited to this SIT project. Raw data collected will not be included in the paper. Respondent names will only be recorded if consent is given.

4. Please discuss other details or procedures of the study that should be known by the Local Review Board:

I believe my research design meets the standards of the following Human Subjects Review category: ______Exempt __X__ Expedited Review ____ Full Review

My research design may be EXEMPT because:

	Research does not involve the participation of human subjects.
	Research relies solely on the use of existing/archival data, documents, or records.
	Research involves the observation of public behavior only.

My research design may require an EXPEDITED review because the:

X	Research involves individual or group contact in no risk/minimal risk circumstances and with non-sensitive topics, and does not utilize children or other vulnerable participants.

	Research involves non-sensitive topics and adult populations from gathered data from voice, video, digital or image recordings made for research purposes.

	Research involves non-sensitive topics and adult populations involving individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior.)

	Research involves non-sensitive topics and adult populations involving surveys, interviews, oral histories, focus groups, program evaluations, human factors evaluations, or quality assurance methodologies.

My research design may require a FULL REVIEW because:

	Children or vulnerable groups are involved.
	Other (identify possible risks, sensitivities, etc.)

Please explain:

I have read and agree to comply with the SIT Study Abroad Statement of Ethics, SIT Human Participants Policy. Yes ☒ No ☐

By signing below, I certify that all of the above information (and that attached) is true and correct to the best of my knowledge and that I agree to fully comply with all of the program's ethical guidelines as noted above and as presented in the program and/or discussed elsewhere in program materials. I further acknowledge that I will not engage in ISP activities until my Academic Director has notified me that both my ISP proposal and my Human Subjects Review application are approved.

Molly Peek

Student's name (printed)

Molly Peek **10/18/2016**

Student's signature date

ATTACHMENTS INCLUDED AS APPROPRIATE
(CHECK ALL THAT ARE ATTACHED):

☐ISP Proposal ☐Interview guide
☐Recruitment letters or fliers ☐Survey instrument
☐Written Informed Consent form (see sample) ☐Instructions to informants

☐Other(s) (please specify):